An ingenuous Decision Support System (iDSS) Approach for Remote area Pregnant Women

Jyothsna G.
School of Chemistry, Physics and Mechanical Engineering, QUT, Brisbane, Australia

Murthy M.
Mathematics and Statistics Discipline, Adelaide

Prasad Y.
School of Chemistry, Physics and Mechanical Engineering, QUT, Brisbane, Australia

Abstract

This paper addresses development of an ingenious decision support system (iDSS) based on the methodology of survey instruments and identification of significant variables to be used in iDSS using statistical analysis. A survey was undertaken with pregnant women and factorial experimental design was chosen to acquire sample size. Variables with good reliability in any one of the statistical techniques such as Chi-square, Cronbach's α and Classification Tree were incorporated in the iDSS. The ingenious decision support system was implemented with Visual Basic as front end and Microsoft SQL server management as backend. Outcome of the ingenious decision support system include advice on Symptoms, Diet and Exercise to pregnant women.

Keywords: Maternal Mortality Rate, Pregnant women, Ingenious decision support system

1 introduction

Every day 1500 women die due to complications in pregnancy or childbirth. The main goal of government is to reduce newborn mortality and maternal mortality significantly by 2015 [1]. Self-medication is a common for people living in rural and remote areas. In many developing nations health care is provided jointly by the government and the private sector. Many programs aimed for prevention of communicable diseases running by many developed countries with the help of the World Health Organization (WHO). Even these programs have not had the desired effect due to faulty implementation. The shortage of and difficulty in retaining primary care providers (physicians, specialists, and nurses), the closing of small hospitals and, conversely, the tendency to hospitalize, financial barriers (cost of travel to services) has identified in many rural areas. This research aims to overcome this deficiency by developing an ingenious decision support system will motivate the pregnant women in a better way than pregnant women who received a pamphlet and referral only.

Ever increasing financial significance, mounting cost for the services and quality improvement of the healthcare sector demands technological augmentation to ease such burdens. Early experimental prototypes and clinical use of DSS over six decades have been of elevated importance and has posed challenges in design and development [1]. Demand for the healthcare services and resources have been increasing steadily in the 20th century [2]. Improvement in medical knowledge and practices may be a contributing factor [1] of this demand however the pressure to control cost and improve quality has been growing [3]. Transformation of healthcare services to a patient driven solution requires assisting healthcare providers and administrators on up skilling their knowledge and understanding of state of the arts scientific and technological development such as information retrieval, data analysis, diagnosis and test, procedure and case management recommendation etc. which are critical information technological protocols for sustainable outcomes.

Designing and developing a simple and reliable decision support model for the given health care scenario is a challenge and requires synergies between patient, physicians and Healthcare service

providers. In particular, healthcare DSSs are faced and challenged with the deluge of data and information, legacy systems (e.g., database silos); lack of expert knowledge integrations, stringent performances, accuracy requirements and basic sciences [1-13]. Our experiment focuses on designing and developing a simple decision support system (iDSS) to help preliminary consultative process for pregnant women in rural Indian settings. The purpose of this paper is to identify the relevant components that are necessary in developing the iDSS.

A structured questionnaire was used in order to answer many aspects such as; prioritising the components in the iDSS , specifying the number of Graphical User Interfaces (GUI) that are representing information gathered and reported, avoiding duplications of components, and improving visual instructions for the end users. It was a cross sectional survey directs over a time period of two months.

2. the approach

2.1application requirements

Based on the relationship among the components, a criterion based process will be developed to assess the information and communication (IC) available for each component and help to select those IC's which satisfies the constraints of any given setting. Such identification of components is done through a statistical approach. Screening and validating significant input variables that are representing the expert knowledge and most contributing factor for the scenario selected.

Identification of components required for developing an iDSS was done in 2 stages. For the first stage, we collected information from medical professionals in and the pregnant women attending the hospitals in the study area, Vijayawada, Andhra Pradesh, using a structured questionnaire. Stage 2 comprises the statistical analysis of the results from stage 1. In order to ensure success in achieving the objectives of answering the research questions a joint methodological approach was implemented through stepwise research process. The initial objective of the study is to elicit the availability of primary health care systems at rural areas. Questionnaire survey was used as a research tool.

Experimental design selected for this survey was Factorial design. General 2^k design the complete model would contain 2^k-1 effects [15]. We grouped variables of face- to-face questionnaire survey into seven. So, a total of 127 pregnant women should be interviewed, as we applied factorial design. 90 responses were considered in the analysis since some pregnant women withdraw from the survey. In our consent form we mentioned that participation of pregnant women in this project is voluntary. Pregnant women can withdraw from participation at any time during the project without comment. The survey was conducted with six Gynaecologists and 90 pregnant women in India.

Two types of questionnaires were prepared. First set for pregnant mothers and the second set for gynaecologists. We met each gynaecologist personally and explained the objectives of the project. Following the ethical clearance (QUT 2009) pregnant mothers were interviewed in the presence of their gynaecologists. There was a complete response rate to the questions asked. Of the 90 women interviewed 75 were from urban and 15 from rural Andhra Pradesh. The interview time on an average was 15 minutes.

2.2 data collection

Surveys can use qualitative (e.g. ask open-ended questions) or quantitative (e.g. use forced-choice questions) measures. Some natural weaknesses reported in relation to questionnaire surveys relate to face-to-face- surveys [11]. There are two basic types of surveys: cross-sectional surveys and longitudinal surveys [12]. Longitudinal surveys involve gathering data over a period of time. An example of a longitudinal survey would be tracking the cessation of smoking before *pregnancy*. Cross sectional surveys are popular for gathering information on important health-related aspects of people's knowledge, attitudes, and practices at a single point in time. An example of a cross sectional survey is complementary and alternative medicine for low-back pain in *pregnancy*.

To prepare the pregnant women questionnaire we referred to the standard health survey, National Family Health Survey (NFHS) [10] (2005-2006), questionnaire used by the Ministry of Health and Family Welfare India. In addition we also had

consultations from a local gynaecologist working in the study area, Vijayawada, Andhra Pradesh.

Some of the specific aspects considered in the pregnant women's questionnaire include vital status, doctor visits, mode of travel, pregnancy details, diet, exercise, family history, health care facility. Section vital status includes age, height, weight, education. Under the section on doctor visits, we included questions on number of check-ups during their pregnancy and possibility of seeing same doctor. Under the section on pregnancy details we included questions on baby weight, whether the baby was born on time, caesarean section, and assistance during delivery.

The section on mode of travel includes distance to the hospital, vehicle using to reach hospital are questioned. Diet section, focused on questions relating to allergies. In exercise section, we considered their daily activity. In the section on family history, we questioned on whether they have smoking habit, drinking habit and digestion problems. In health care facility section, health care centers near to their place, distance travel to reach nearest hospital questions were considered. Total of 47 questions included in questionnaire.

Some of the specific aspects considered in the Gynaecologists questionnaire include Healthcare, Contacting pregnant mother through telephone Section healthcare includes Healthcare in rural set-up, Managing healthcare, Features of my system, Need of having primary health care at rural set-up. Under the section on contacting pregnant mother through telephone, we included questions on suggestions through telephone, shortage of doctors, doctor's response through telephone.

One can question that; isn't information from gynaecologists adequate for developing iDSS? However as pregnant women will be end users we thought it would be useful to obtain information from pregnant women. There was many ways to get information like face to face interviews, group interviews, questionnaires. We select questionnaire

2.3variables considered in idss

Data collected from face-to-face questionnaire survey was analysed through statistical analysis. Statistical techniques like Chi-square, Cronbach's α and classification tree were applied to the data. because it lends an automatic architecture to the iDSS. In order to develop logical flow for iDSS we use statistical analysis to obtain important variables. The purpose of utilizing the "systematic selection procedure sampling" technique is to collect as much information as possible to finding answers to the research questions.

2.2.1Variable validation (Statistical Analysis)

To identify the relation among the components, we analysed the information using three different statistical approaches. To assess the goodness of fit between variables, to be considered in the iDSS, and their association (independent/dependent) we used Chi-square test. Mostly for all cases where the cell frequencies were more than five we used a general Chi-square, however where the cell frequencies were less than five we used a two tailed Fishers exact test. All the analysis was carried out using SPSS, a statistical software, version 17[9].

Apart from understanding individual associations among variables we were also interested in looking at pair-wise co-relations. For finding pair-wise correlations between variables the common statistical tool, Cronbach's α, was used. Once again was implemented in SPSS. A commonly-accepted rule of thumb is that when $\alpha = 0.6\text{-}0.7$ indicates acceptable reliability, and 0.8 or higher indicates good reliability. High reliabilities (0.95 or higher) are not necessarily desirable, as this indicates that the items may be entirely redundant. The goal in using Cronbach's α is to design a reliable instrument (internally consistent), and at the same time have components with unique information as well.

Classification tree (also known as decision tree): classification trees were used to predict categorical dependent variables. Benefit of Classification tree is it allows understanding the relationship across categories and also identifying the relationship between components. Such understanding allows the design of Graphical User Interface screens in the DSS.

Significant variables obtained from the analysis were used in the ingenious decision support system for providing awareness. As we are from non-medical background, we contact gynaecologists in order to dig up information regarding these significant variables. That information was included in the

iDSS. The survey findings would cover the way and provide appropriate way for second phase of research to study the existing health services in depth. Expected outcome of statistical analysis is acquiring significant variables essential during pregnancy. With these outcomes ingenious decision support system was developed.

Main objective of the study is developing ingenious decision support system for enhancing awareness. Study tool for this study is Visual basic for creating user interfaces as front end and SQL server management for database connectivity. Ingenious decision support was developed by considering significant variables acquired from statistical analysis. One can question that; is it sufficient in providing information for only significant variables? However our intent is to develop a system for significant things considered during pregnancy. This system also assists in monitoring their Blood pressure, Glucose Meter and weight. This ingenious decision support system will motivate the pregnant women in a better way than pregnant women who received a pamphlet and referral only.

Suggestions comprise of information on symptoms, diet to be taken and amount of exercise to be done (see figure 2)

2.3.1 software and hardware requirements

To have our iDSS at rural areas they should have following requirements; Personal computer, software's like visual basic and Microsoft SQL server management should be installed. Hardware required for PHC centre with 600MHz processor. Random access memory (RAM) was 192 Mb up to a maximum of 256 Mb. The operating system is Windows 2000 Service Pack 4, Windows XP Service Pack 2, Windows Server 2003 Service Pack 1, or Windows Vista.

2.4Prototype Development

2.4.1 The application interface

Our system Ingenious Decision Support system is modelled in a step wise manner to obtain the output of iDSS. The various steps are as follows: Entry form was the first step to the iDSS system. Already registered women can enter the system by providing a unique ID. The second step to the iDSS system is registration. The system will generate a unique ID for the pregnant women by taking the first characters of their name and guardian name. This unique ID will assist in saving and retrieving the records when required.

Statistical analysis was used to find the relationship among components which helped design the architecture of the proposed iDSS. This step was the key the element for the iDSS in assessing pregnant women's circumstances. Four categories are involved in this step. Crystal report was used to save data in the database. Depending on information in all the four categories, a system risk is generated (see Figure 1). Considering all the factors from Step 1 to Step4, the system generates suggestions for pregnant women.

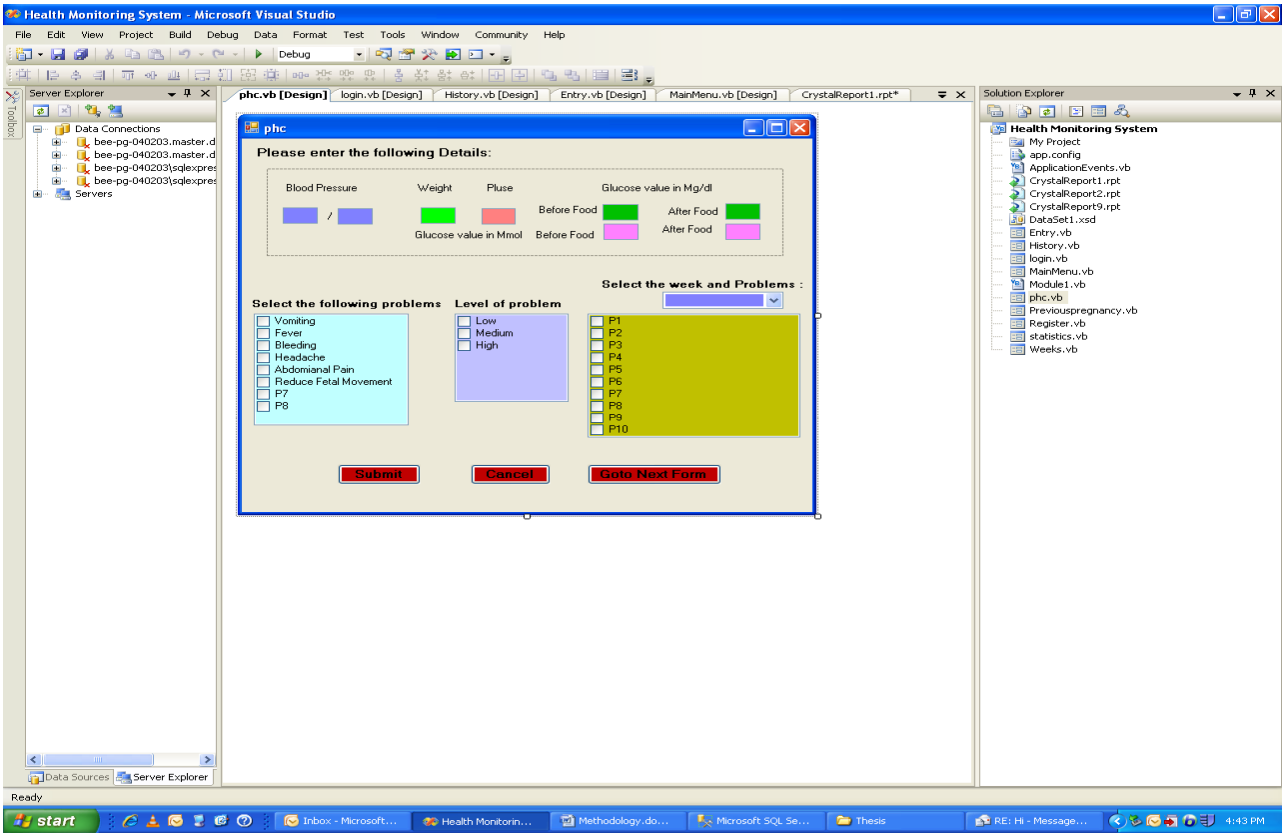

Figure 1: *GUI screen for manipulating blood pressure, glucose meter, pulse and weight*

2.4.2 Reporting

Some case studies for pregnant women using the decision support system follow.

Case study 1: Normal situation

Age: 21; Pregnancy parity: first; Tetanus: no; Place of work: working from home; Abortions: no; Blood pressure: 110/96; Weight: 60; Pulse: 80; Glucose: 5.00, 5.56 Mmol; Pregnancy week: 12; Problem: vomiting.

Recommendations from the ingenious decision support system were:

1. Blood pressure slightly increased, please take care! Glucose is normal. Contact doctor and have tetanus injection.

2. Symptoms that can be faced during this week are heartburn and sleeplessness. Take care of diet.

3. Gentle Exercise

4. Diet to be taken:

1. Eat less and have six meals in a day instead of having three
2. Chew your food adequately and eat slowly
3. Do not eat before going to bed
4. Raise the head of your bed
5. Stay away from citrus juices and spicy meals
6. Increase the amount of fibre in your diet.

Case study 2: Critical situation

Age: 18; Pregnancy parity: first; Tetanus: yes; Place of work: away from home; Abortions: yes.

Blood pressure: 180/120; Weight: 60; Pulse: 80; Glucose: 4.00, 5.56 Mmol; Pregnancy week: 20.

Recommendations from the ingenious decision support system were:

1. High blood pressure; should see gynaecologist! Glucose is normal. Avoid long journeys.

2. Symptoms

1. Breast changes: tenderness
2. Frequent urination
3. Constipation
4. Stretch marks
5. Itching
6. Occasional headaches
7. Heart burn

3. Gentle exercise, such as walking, is helpful in stimulating your blood flow.

4. Diet to be taken: Normal diet (food hygiene is important).

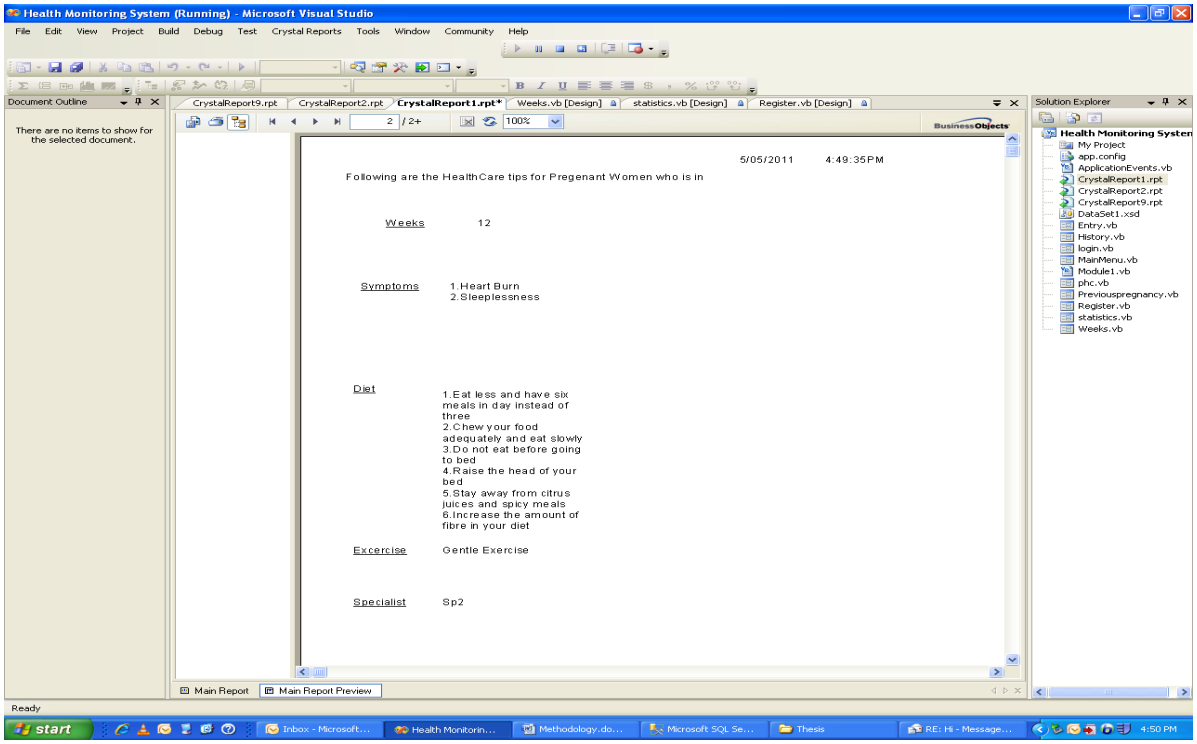

Figure 2: Suggestions from iDSS

3 Example application- profile of andhra pradesh

Andhra Pradesh, the fifth largest state in India is located in the south eastern part of country with its neighbouring states Tamil Nadu, Maharashtra, Chattisgarh, Orissa and the Bay of Bengal. The state has 23 districts, including the capital city Hyderabad. Based on the socio cultural and geographical aspects state is divided into 3 regions: Coastal Andhra, Telangana and Rayalaseema. Andhra Pradesh is predominately rural and agricultural sector, with 73% of total population living in villages and hamlets, according to senses 2001[5].

According to 1974-79 five year plan maternal health, child health and nutrition services were integrated with family planning services. In 1996, safe motherhood and child health services were incorporated into the reproductive and child health program [2]. The major factors for the persistently high Maternal Mortality Rate (MMR) are the low awareness among women about risks and access to services. The failure of the public health system at the grass roots level to provide skilled birth attendant for every child is also a critical factor in the high Infant Mortality Rate (IMR) and MMR[5] .

From the recent health report developed by Andhra Pradesh, it can be learned that there is a shortfall for health care providers (56%) community health centres (65.28%) physicians (74.85%) and paediatricians (67.66%). In the infra-structure and key health personnel there is a shortage of 18.4 % (Primary Health Centres, PHC), 2.5 % [Multipurpose workers/Auxiliary Nurse Midwife (ANM)] and 25% (Nurse and Midwife (staff nurse).

In addition to this report by the government of Andhra Pradesh, studies by Prakasamma[7] and Mavalankar and vora [8] show that the PHC's that were to be open on a 24-hours for 7 day basis was adequately staffed or equipped for round the clock maternal and neo natal services. Moreover the report also highlights that the staff neither received technical guidance and support nor had adequate equipment and supplies and had to stay alone during nights with poor security. Furthermore the report also highlights, that the staff reported, that it was difficult for them to be available round the clock.

The use of an inductive computer program for producing support systems for pregnant woman was developed by Mault [4]. Similarly, the use of DSS in primary health care has been developed by Klercker and Klercker [5]. Other areas of health which benefited from the use of decision support systems are the cardiovascular sciences [6]. In order to fulfil constrains highlighted above, we propose developing an iDSS for enhancing awareness among women on the use of health services during early pregnancy trimesters. This decision support scheme can be used in conjunction with the current schemes such as Janani surakshana yojana. Janani surakshana yojana is a program intended for providing care to rural poor women who undergo institutional delivers whether in private or public hospitals[1]. For developing such a decision support scheme we need to identify the components relevant to first three trimesters of pregnancy and find relationship among components for the architecture of proposed iDSS.

4 results

A simple straight forward one time study result, which is for general information and not for specific decision, probably doesn't need evidence of reliability or validity. However, if the results from a study may lead to major changes, concerns a sensitive issue, then one should dread about validity and reliability. As the objective of the project is of second type we intend to test and validate our questionnaire, where reliability is defined as eliciting the consisting responses. Usually there are two types of reliability that one may look for in a questionnaire: 1) consistency within the questionnaire and, 2) consistency over time. In over analysis we looking for first type of reliability. This reliability was measured through pair-wise correlations using Cronbach's α.

The pair-wise correlations were computed between age component, doctor visits, baby born, baby weight, caesarean section, assistance during pregnancy, location of health care facility and distance from it, occupation, and place of work.

Table 1: Important Variables selected and their relevance

Attribute	Chi-square	Cronbach's α	Classification Tree	Final Inclusion
Place of residence	0.328	Not Included	Not Included	0.328
Seeing same doctor	0.328	Not Included	0.14	0.14
Education	0.174	Not Included	Not Included	0.174
Tetanus injection	0.528	Not Included	Not Included	0.528
Baby weight	Not Included	0.85	Not Included	0.85
Previous Baby born	Not Included	0.85	Not Included	0.85
Place of child birth	0.102	Not Included	Not Included	0.102
Assisted delivery	Not Included	0.84	Not Included	0.84
Pregnancy Parity	0.490	Not Included	Not Included	0.490
Doctor visits	Not Included	0.48	Not Included	0.48
Occupation	Not Included	0.52	Not Included	0.52

The survey is done to find most significant variables required in the development of the iDSS. After the survey was done variables were separated into two groups. One of group of variables is for providing information for pregnant women. Another group of variables was to know availability of health care facilities at their living area

Variables such as distance to reach primary health care centre, and the use of medical facility, availability of health care centre are the aspects indicators required to know the availability of the health care.

Considering the medical importance there may be a variety of variables which needs to be considered in the architecture of iDSS. However, information on all these variables is not being collected in this project. Among the variables considered as important the variables such as place of residence, seeing same doctor, place of residence, education, previous pregnancy, awareness of tetanus, pregnancy parity, times tetanus taken, distance of primary care centre, time taken to reach nearest primary health care centre, baby weight, availability of health care centre, distance to health care facility, antenatal check-up, place of child birth, assisted delivery, baby born are statistically significant.

5discussions and conclusions

The outcome of this face-to-face questionnaire survey is to obtain significant variables compulsory during pregnancy. This survey shows that there was shortage in the availability of doctors at rural areas. Most of the gynaecologists who participate in the survey accepted that most of the pregnant women at rural areas are not having awareness about significant things that are essential during pregnancy. This clearly shows having schemes like Janani surakshana yojana [5] is a program intended for providing care to rural poor women.

Information management plays an important role in health care process as it depends on both information and knowledge. Many researchers [1, 13], applied decision support systems for several health care applications includes cardiac, chronic diseases, diabetes, pregnant women were benefited. Obviously our ingenious decision support system will motivate the pregnant women in a better way than pregnant women who received a pamphlet and referral only.

This survey has several limitations. First, the questionnaire has not been assessed for test-retest reliability. Second, difficult to reach in person, likely to be answered fully and honestly, difficulties in interviewer's verbal and non-verbal behaviour. These are intrinsic limitations of face-to-face questionnaire survey [12]. However, these limitations could no way affect the value and overview that could be extracted over the analysis of data of this survey which was conducted by captivating the suggestions from gynaecologists.

5.1 future work

There is enormous scope for further work on the proposed ingenious decision support system. The following work can be done from theoretical point of view:

- Connecting the iDSS database to the nearest hospital to help doctors to know the situation of pregnant women prior to arriving at the hospital
- Testing the proposed ingenious decision support system with more gynaecologists to allow exploration of the mechanisms of the system.
- Conducting a survey with a larger sample size and longer follow-ups to assess significant pregnancy issues
- Conducting randomized control trials to determine system strength

The following work can be done from implementation point of view:

- Incorporating more parameters to improve system performance and assist pregnant women(Three parameters are monitored in the current system)

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